Appendix C
Glossary

Words appearing in *italic* are defined in this glossary.

absorbed dose - Energy absorbed per unit mass from any kind of ionizing *radiation* in any kind of matter. Unit: *rad*.

activation product - Material made radioactive by *exposure* to *radiation* from a source such as a nuclear reactor's neutrons.

adsorption - The accumulation of gases, liquids, or solutes on the surface of a solid or liquid.

alpha particle - A positively charged particle ejected spontaneously from the nuclei of some radioactive elements. It has low penetrating power and short range. The most energetic alpha will generally fail to penetrate the skin. Alphas are hazardous when an alpha-emitting *isotope* is introduced into the body.

anion - A negatively charged ion.

aquifer - Permeable geologic unit that can hold and/or transmit significant quantities of water.

background radiation - *Radiation* in the natural environment, including cosmic rays from space and *radiation* from naturally occurring radioactive elements in the air, in the earth, and in our bodies. In the United States, the average person receives approximately 300 *millirems* of background *radiation* per year.

bank storage - Hydrologic term that describes river water that flows into and is retained in permeable stream banks during periods of high river stage. Flow is reversed during periods of low river stage.

becquerel (Bq) - Unit of *radioactivity* equal to one nuclear transformation per second (1 Bq = 1 disintegration/s). Another unit of *radioactivity*, the *curie*, is related to the becquerel: 1 Ci = 3.7×10^{10} Bq.

beta particle - A charged particle emitted from a nucleus during radioactive *decay*. Large amounts of beta particles may cause skin burns and are harmful if they enter the body. Beta particles are easily stopped by a thin sheet of metal or plastic.

boundary dose rate - *Dose rate* measured or calculated at publicly accessible locations on or near the Hanford Site boundary.

cation - A positively charged ion.

clean closed - A facility is classified as "clean closed" under RCRA regulations when all dangerous waste has been removed and *groundwater* monitoring is no longer required.

collective total effective dose equivalent - Sum of the *total effective dose equivalents* for individuals composing a defined population. The units for this are "*person-rems*" or "*person-sieverts*."

committed dose equivalent - The *dose equivalent* to organs or tissues that will be received from an intake of radioactive material by an individual during the 50-year period following intake.

committed effective dose equivalent - The sum of the *committed dose equivalent* from sources inside the body.

composite sample - Sample formed by mixing discrete samples taken at different times or from different locations.

confined aquifer - An *aquifer* bounded above and below by less-permeable layers. *Groundwater* in the confined aquifer is under a pressure greater than atmospheric pressure.

continuous sample - Sample formed by the continuous collection of the medium or contaminants within the medium during the entire sample period.

controlled area - An area to which access is controlled to protect individuals from *exposure* to *radiation* or radioactive and/or hazardous materials.

cosmic radiation - High-energy subatomic particles and electromagnetic *radiation* from outer space that bombard the earth. Cosmic *radiation* is part of natural *background radiation*.

crib - An underground structure designed to receive liquid waste that percolates into the soil directly or percolates into the soil after having traveled through a connected tile field.

curie (Ci) - A unit of *radioactivity* equal to 37 billion (3.7×10^{10}) nuclear transformations per second. The curie is related to the *becquerel*: 1 *Bq* = 0.000000000027 Ci.

decay - The decrease in the amount of any radioactive material with the passage of time. See *radioactivity*.

decay product - The atomic nucleus or nuclei that are left after radioactive transformation of a radioactive material. Decay products may be radioactive or non-radioactive (stable). Formerly called "daughter product." See *radioactivity*.

deep-dose equivalent - The *dose equivalent* at a tissue depth of 1 centimeter from *radiations* originating outside of the body.

derived concentration guide (DCG) - Concentrations of *radionuclides* in air and water that an individual could continuously consume, inhale, or be immersed in at average annual rates, and not receive an *effective dose equivalent* of greater than 100 *millirems* per year.

detection level - Minimum amount of a substance that can be measured with a specified or implied confidence that the analytical result is greater than zero.

dispersion - Process whereby *effluents* are spread or mixed as they are transported by *groundwater* or air.

dose equivalent - Product of the *absorbed dose*, the quality factor, and any other modifying factors. The dose equivalent is a quantity for comparing the biological effectiveness of different kinds of *radiation* on a common scale. The unit of dose equivalent is the *rem*. A *millirem* is one one-thousandth of a *rem*.

dose rate - A quantity indicating how fast or slow *radiation* dose is accumulated over time. "Dose rate" is generally used to denote *absorbed dose* rate, *dose equivalent* rate, etc. Units: *rads* or millirads per hour (rad/h or mrad/h) for *absorbed dose* rate; *rems* or *millirems* per hour (rem/h or mrem/h) for *dose equivalent* rate.

dosimeter - Portable device for measuring the total accumulated *exposure* or *absorbed dose* from ionizing *radiation* fields.

effective dose - See "*effective dose equivalent*."

effective dose equivalent - The sum of products of *dose equivalent* to each tissue or organ and the tissue weighting factor for each tissue or organ. The tissue weighting factors put doses to various tissues and organs on an equal basis in terms of health *risk*.

effluent - Liquid or gaseous waste streams released from a facility.

effluent monitoring - Sampling or measuring specific liquid or gaseous *effluent* streams for the presence of pollutants.

exposure - The interaction of an organism with a physical agent (e.g., *radiation*) or a chemical agent (e.g., arsenic) of interest. Also used as a term for quantifying x and *gamma radiation* fields. See *roentgen*.

external radiation - *Radiation* originating from a source outside the body.

facies - The aspect, appearance, and characteristics of a rock unit, usually reflecting the conditions of its origin (Bates and Jackson 1980).

fallout - Radioactive materials that are released into the earth's atmosphere following a nuclear explosion or atmospheric release and that eventually fall to earth.

fission - The splitting or breaking apart of a nucleus into at least two other nuclei, accompanied with a release of a relatively large amount of energy. For example, when a heavy atom such as uranium is split, large amounts of energy, including *radiation* and neutrons, are released along with the new nuclei (which are *fission products*; see below).

fission products - Elements formed from fissioning. Many fission products are radioactive.

gamma radiation - High-energy electromagnetic *radiation* originating in radioactive *decay* or nuclear reactions. If needed, shielding can be lead, steel, concrete, earth, or water. The needed thickness of the shield is determined by the intensity and duration of *exposure*.

grab sample - A short duration sample (e.g., air, water, soil) that is "grabbed" from the collection site.

grand mean - A "means of means" or an "overall *mean*" where there is some subdivision of the data where means were already provided for each subdivision.

groundwater - Subsurface water that is in the pore spaces of soil and geologic units.

gray (Gy) - Unit of *absorbed dose* in the International System of Units (SI) equal to 1 joule per kilogram. 1 Gy = 100 *rad*.

half-life - Length of time in which a radioactive substance will lose one half of its *radioactivity* by *decay*. Half-lives range from a fraction of a second to billions of years, and each *radionuclide* has a unique half-life.

high-level waste - Highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains *fission products* and other *radioisotopes* in sufficient concentrations to require permanent isolation.

internal radiation - *Radiation* from radioactive material inside the body.

ion exchange - The reversible exchange of one species of ion for a different species of ion within a medium.

irradiation - *Exposure* to *radiation*.

isotopes - *Nuclides* of the same chemical element with differing number of neutrons. *Isotopes* of the same element (e.g., ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu) have almost identical chemical properties.

legacy waste - Waste that was generated prior to cleanup associated with deactivation and decommissioning.

low-level waste - Radioactive waste that is not high-level radioactive waste, spent nuclear fuel, *transuranic waste*, byproduct material, or naturally occurring radioactive material.

lysimeter - An instrument to measure the water percolating through soil and determine the materials dissolved by the water.

maximally exposed individual - A hypothetical member of the public residing near the Hanford Site who, by virtue of location and living habits, could receive the highest possible *radiation* dose from *radionuclides/radiation* originating from Hanford.

mean - Average value of a series of measurements. The mean, X, was computed as:

$$X = \frac{1}{n}\sum_{i=1}^{n} X_i$$

where n is the number of measurements and X_i is the ith measurement.

median - Middle value in a set of results when the data are ranked in increasing or decreasing order.

millirem - A unit of *radiation dose equivalent* that is equal to one one-thousandth (1/1000) of a *rem*. According to U.S. Department of Energy standards, an individual member of the public may receive no more than 100 millirems per year from a site's operation. This limit does not include *radiation* received for medical treatment or the ~300 millirems that people receive annually from natural *background radiation*.

minimum detectable amount or concentration - Smallest amount or concentration of a chemical or radioactive material that can be reliably detected in a sample.

mitigation - Prevention or reduction of expected *risks* to workers, the public, or the environment.

mixed waste - A dangerous, extremely hazardous, or acutely hazardous waste that contains both a nonradioactive hazardous component and a radioactive component.

noble gas - Any of a group of chemically and biologically inert gases that includes argon, krypton, and xenon. These gases are not retained in the body following inhalation. The principal *exposure* pathways for radioactive noble gases are direct external dose from the surrounding air.

nuclide - A particular combination of neutrons and protons. A *radionuclide* is radioactive.

offsite locations - Sampling and measurement locations outside the Hanford Site boundary.

onsite locations - Sampling and measurement locations within the Hanford Site boundary.

operable unit - A discrete area for which an incremental step can be taken toward comprehensively addressing site problems. The cleanup of a site can be divided into a number of operable units, depending on the complexity of the problems associated with the site.

outfall - End of a drain or pipe that carries wastewater or other *effluents* into a ditch, pond, or river.

person-rem or person-sievert (person-Sv) - Unit of *collective total effective dose equivalent*. 1 person-Sv = 100 person-rems.

photon - A particle of high-energy electromagnetic *radiation*, characterized by energy, frequency, and wave length. *Gamma radiation* and x *radiation* (x-rays) are both comprised of photons.

plume - The cloud of a pollutant in air, surface water, or *groundwater* formed after the pollutant is released from a source.

plutonium - A heavy, radioactive, manmade metallic element consisting of several *isotopes*. One important *isotope* is ^{239}Pu, which is produced by the *irradiation* of ^{238}U. Routine analysis cannot distinguish between the ^{239}Pu and ^{240}Pu *isotopes*; hence, the term $^{239/240}$Pu as used in this report is symbolic of the presence of one or both of these *isotopes* in the analytical results.

quality assurance - Actions that provide confidence that an item or process meets or exceeds that user's requirements and expectations.

quality control - Comprises all those actions necessary to control and verify the features and characteristics of a material, process, product, or service to specified requirements. Quality control is an element of *quality assurance*.

rad - The unit of *absorbed dose*. 1 rad = 0.01 *gray* (Gy).

radiation - The energy emitted in the form of *photons* or particles such as those thrown off by transforming (*decaying*) atoms. For this report, radiation refers to ionizing types of radiation; not radiowaves, microwaves, radiant light, or other types of non-ionizing radiation.

radiation limit - The permissible upper bounds of *radiation* doses.

radioactivity - Property possessed by some *radioisotopes* of emitting *radiation* (such as alpha, beta, or gamma *photons*) spontaneously in their *decay* process.

radioisotope - An unstable *isotope* of an element that *decays* or disintegrates spontaneously, emitting *radiation* (Shleien 1992).

radionuclide - A species of atoms having a particular number of protons (Z), a particular number of neutrons (A), and a particular atomic weight (N = Z + A) that happens to emit *radiation*. Carbon-14 is a radionuclide. Carbon-12 is not and is called just a "*nuclide*."

recruitment - Survival from one life form or stage to the next or from one age class to the next.

rem - A unit of *dose equivalent* and *effective dose equivalent*.

remediation - Reduction of known *risks* to the public and environment to an agreed upon level.

risk - The probability that a detrimental health effect will occur.

roentgen (R) - Unit of x-ray or gamma *photon exposure* measured in air, historically used to describe *external radiation* levels. An *exposure* of 1 roentgen typically causes an *effective dose* of 1 *rem*.

sievert (Sv) - Unit of *dose equivalent* and *effective dose equivalent* in the International System of Units (SI) equal to 100 *rems*.

special case waste - Waste for which there is an undetermined disposal path because of high levels of *radioactivity* and difficulties in characterization, classification, and packaging.

specific retention facilities - Historical structures consisting of cribs, ditches, trenches, or holes in the ground that received relatively small volumes of high concentration liquid radioactive waste. The small volume of liquid waste was designed to prevent flushing of the contaminants through the soil column to the *groundwater*.

spectrometer - A spectroscope with a calibrated scale for measuring the positions of spectral lines.

spectroscopy - The branch of physics concerned with the production, measurement, and interpretation of electromagnetic spectra arising from either emission or absorption of radiant energy by various substances.

spent fuel - Uranium metal or oxide and its metal container that have been used to power a nuclear reactor. It is highly radioactive and typically contains *fission products*, *plutonium*, and residual uranium.

standard error of the mean - A measure of the precision of a *mean* of observed values; that is, an estimate of how close a *mean* of observed values is expected to be to the true *mean*. The standard error (SE) of the mean is computed as

$$SE = \sqrt{\frac{S^2}{n}}$$

where S^2 is the variance of the measurements, n, computed as

$$S^2 = \frac{1}{n - 1} \sum_{i=1}^{n} (X_i - X)^2$$

X is the *mean* of n measurements.

This estimator, S^2, includes the variance among the samples and the counting variance. The estimated S^2 may occasionally be less than the average counting variance.

thiourea - An organic chemical soluble in cold water used in photography, photocopying, and thyroid medication.

transient calibration - The trial-and-error adjustment of aquifer parameters under conditions of changing flow velocity.

transuranic - An element with an atomic number greater than 92 (92 is the atomic number of uranium).

transuranic waste - Waste containing more than 100 nanocuries (10^{-9} *curies*) of alpha-emitting *transuranic isotopes* (*isotopes* with atomic numbers greater than uranium) per gram of waste with *half-lives* greater than 20 years.

thermoluminescent dosimeter - A device containing a material that, after being exposed to beta and/or *gamma radiation*, emits light when processed and heated. The amount of light emitted is proportional to the *absorbed dose* to the thermoluminescent dosimeter.

total effective dose equivalent - The sum of *committed effective dose equivalent* from intakes of radioactive material and *deep-dose equivalent* from *external radiation*. Unit: *rem* or *sievert*.

unconfined aquifer - An *aquifer* containing *groundwater* that is not confined above by relatively impermeable rocks. The pressure at the top of the unconfined aquifer is equal to that of the atmosphere. At Hanford, the unconfined aquifer is the uppermost *aquifer* and is most susceptible to contamination from site operations.

vadose zone - Underground area from the surface to the top of the *water table* or *aquifer*.

volatile organic compounds - Lightweight organic compounds that vaporize easily. Used in solvents and degreasing compounds as raw materials, volatile compounds are generally considered to be below the molecular weight of C_{10} hydrocarbons.

water table - Theoretical surface represented by the elevation of water surfaces in wells penetrating only a short distance into the *unconfined aquifer*.

wind rose - Star-shaped diagram that shows how often winds of various speeds blow from different directions, usually based on yearly averages.

References

Bates, R. L. and J. A. Jackson (eds.). 1980. *Glossary of Geology*. American Geological Institute, Falls Church, Virginia.

Shleien, B. (ed.). 1992. *The Health Physics and Radiological Health Handbook, Revised Edition*. Scinta, Inc., Silver Spring, Maryland.